DATA SHEET

TDA1561Q
2 × 23 W car radio power amplifier

Preliminary specification
Supersedes data of September 1991
File under Integrated Circuits, IC01

1995 May 08

Philips Semiconductors

PHILIPS

2 × 23 W car radio power amplifier TDA1561Q

FEATURES

- Low power dissipation due to switching from SE to BTL mode
- High common-mode rejection ratio (CMRR)
- Mute/standby/BTL-disable switch (mode select pin)
- Zero-crossing mute
- Load dump protection
- Short-circuit safe to ground, V_P and across load
- Loudspeaker protection
- Switches to single-ended operation at excessive crystal temperature.

GENERAL DESCRIPTION

The TDA1561Q is a monolithic power amplifier in a 13-lead plastic DIL-bent-SIL power package (DBS13P). It contains two identical 23 W amplifiers. The power dissipation is minimized by switching from single-ended (SE) to bridge-tied load (BTL) mode, when a higher output voltage swing is required. The device is primarily developed for car radio applications.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	supply voltage	DC biased	6.0	14.4	18	V
		non-operating	–	–	30	V
		load dump protected	–	–	50	V
I_{ORM}	repetitive peak output current		–	–	4	A
$I_{q(tot)}$	total quiescent current		–	95	150	mA
I_{stb}	standby current		–	1	50	μA
$\|Z_I\|$	input impedance		–	60	–	kΩ
P_o	output power	R_L = 4 Ω; THD = 10%	21	23	–	W
G_v	closed loop voltage gain		31	32	33	dB
CMRR	common mode rejection ratio	f_i = 1 kHz; R_S = 0 Ω	–	80	–	dB
SVRR	supply voltage ripple rejection	f_i = 1 kHz; R_S = 0 Ω	45	55	–	dB
$\|\Delta V_O\|$	DC output offset voltage		–	–	150	mV
α_{cs}	channel separation	R_S = 0 kΩ	40	–	–	dB
$\|\Delta G_v\|$	channel unbalance		–	–	1	dB

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA1561Q	DBS13P	plastic DIL-bent-SIL power package; 13 leads (lead length 12 mm)	SOT141-6

BLOCK DIAGRAM

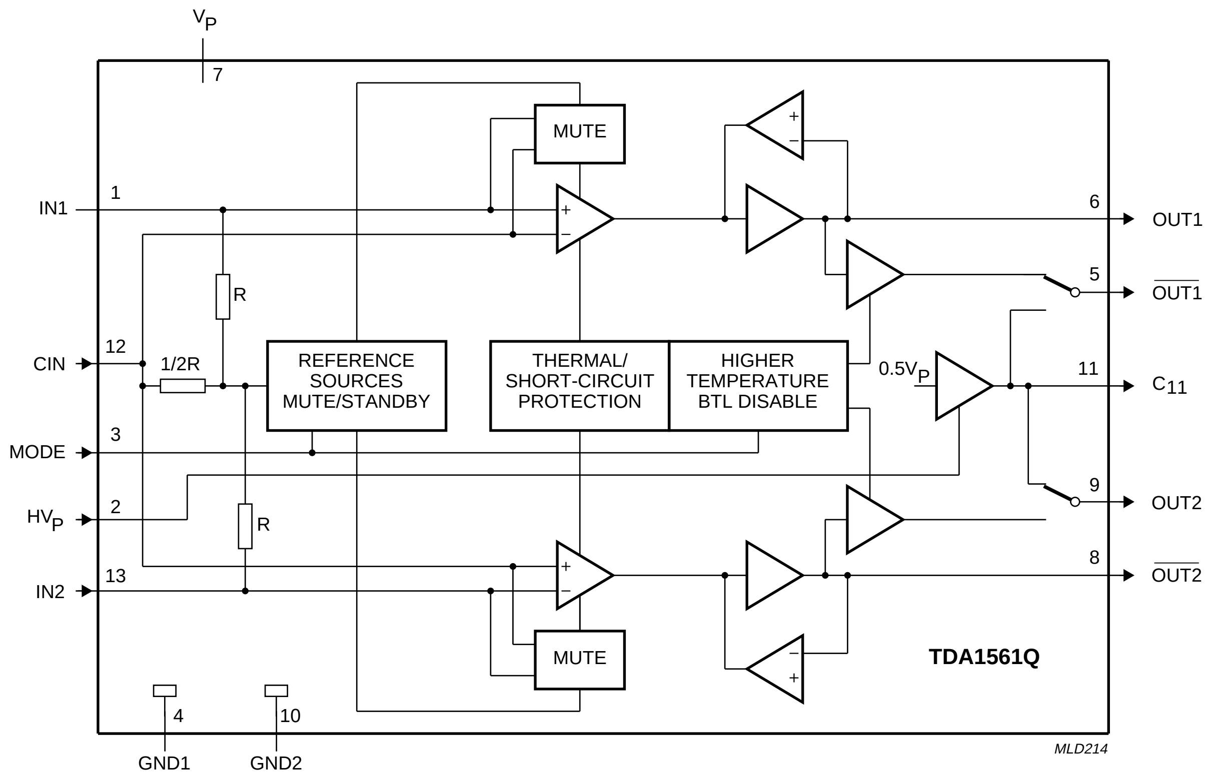


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
IN1	1	input 1
HV_P	2	half supply voltage control input
MODE	3	mute/standby/BTL-disable mode select switch input
GND1	4	ground 1
$\overline{OUT1}$	5	inverting output 1
OUT1	6	non-inverting output 1
V_P	7	supply voltage
$\overline{OUT2}$	8	inverting output 2
OUT2	9	non-inverting output 2
GND2	10	ground 2
C_{11}	11	single-ended electrolytic output
CIN	12	common input
IN2	13	input 2

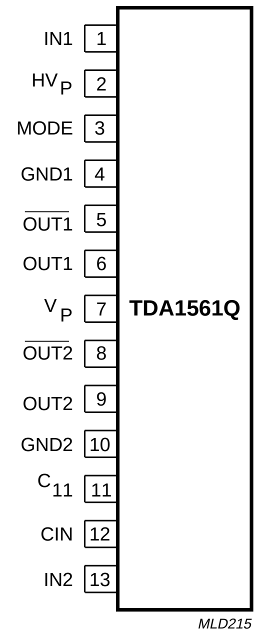


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA1561Q contains two identical amplifiers with differential inputs. At low output power, up to output amplitudes of 3 V (RMS) at V_P = 14.4 V, the device operates as a normal single-ended (SE) amplifier. When a larger output voltage swing is required, the circuit switches internally to bridge-tied load (BTL) operation.

With a sine wave input signal the power dissipation of the TDA1561Q is approximately 50% lower than a conventional BTL amplifier at 2 W output power (see Fig.3).

In normal use, when the amplifier is driven with music signals, the high (BTL) output power is only required for a small percentage of time. Assuming a music signal (P_o = 1.6 W) has a normal (Gaussian) amplitude distribution, the reduction in dissipation is approximately 40% when compared to a BTL amplifier with the same output power (see Fig.4). The heatsink should be designed for use with music signals. With such a heatsink, the thermal protection disables the BTL mode when the crystal temperature exceeds 145 °C. In this event the output power is limited to 5 W per amplifier when driven with a worst case sine wave input signal.

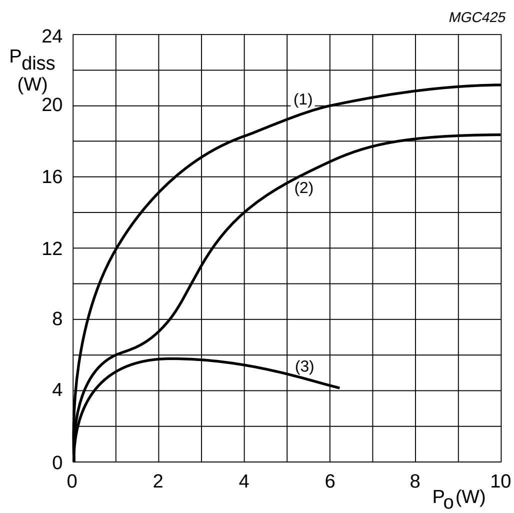
The gain of each amplifier is internally fixed at 32 dB. With the mode select input the device can be switched to the following modes:

- Low standby current (<50 μA)
- Mute condition, DC adjusted
- On operation
- SE only operation (BTL disabled).

The device is fully protected against short-circuiting of the outputs to ground and to V_P. It is also protected against short-circuiting the loudspeaker and high crystal temperatures. In the event of a permanent short-circuit to ground or V_P, the output stage will be switched off causing a low dissipation. With permanent short-circuiting of the loudspeaker, the output stage will repeatedly be switched on and off. The duty cycle in the on condition is low enough to prevent excessive dissipation (duty cycle is approximately 0.1%).

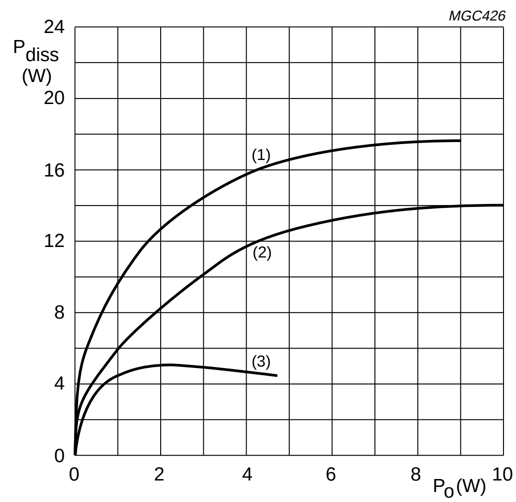
To avoid plops during switching from mute to on or from on to mute/standby, a built-in zero-cross detector only allows switching at zero input voltage. However, when V_P drops below 6 V (e.g. engine start), the circuit mutes immediately to avoid clicks coming from electronic circuitry preceding the power amplifier.

The voltage of the SE electrolytic capacitor is always kept to $0.5V_P$ by a voltage buffer (see Fig.1). The value of the SE electrolytic capacitor has an important influence on the output power in SE mode, especially at low signal frequencies, a high value is then recommended to minimize dissipation.



(1) For conventional amplifier BTL.
(2) For TDA1561Q.
(3) For conventional amplifier SE.

Fig.3 Sine wave signal; $P_{diss} = f(P_o)$.



(1) For conventional amplifier BTL.
(2) For TDA1561Q.
(3) For conventional amplifier SE.

Fig.4 Pink noise with IEC-268 filter; $P_{diss} = f(P_o)$.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage	operating	–	18	V
		non-operating	–	30	V
		load dump protection; $t_r \geq 2.5$ ms	–	50	V
$V_{P(sc)}$	AC and DC short-circuit safe voltage		–	18	V
$V_{P(r)}$	reverse polarity		–	6	V
I_{OSM}	non-repetitive peak output current		–	6	A
I_{ORM}	repetitive peak output current		–	4	A
P_{tot}	total power dissipation		–	60	W
T_{stg}	storage temperature		–55	+150	°C
T_{amb}	operating ambient temperature		–40	+150	°C
T_c	crystal temperature		–	150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air	40	K/W
$R_{th\ j\text{-}c}$	thermal resistance from junction to case	1.3	K/W

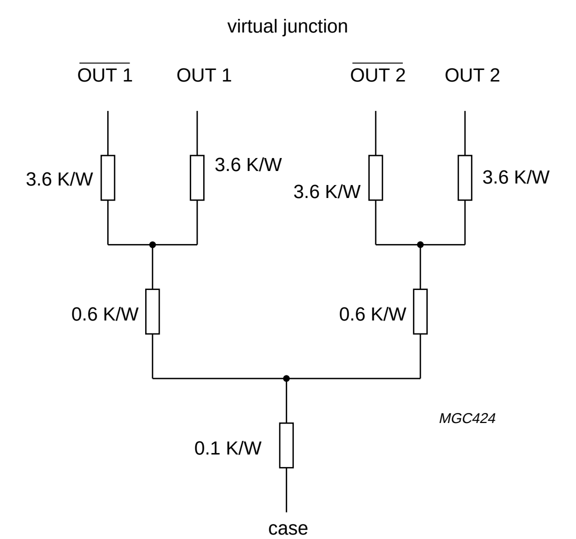


Fig.5 Equivalent thermal resistance network.

Heatsink design

There are two parameters that determine the size of the heatsink. The first is the rating for the virtual junction temperature and the second is the ambient temperature at which the amplifier must still deliver its full power in the BTL mode.

VIRTUAL JUNCTION TEMPERATURE

With a **conventional BTL amplifier**, the maximum power dissipation with a 4 Ω load and driven with a music signal (at each amplifier) will be approximately 2 × 6 W. At a virtual junction temperature of 150 °C and $T_{amb(max)}$ at 60 °C, $R_{th\ vj\text{-}c}$ = 1.3 K/W and $R_{th\ c\text{-}hs}$ = 0.2 K/W (the value of $R_{th\ c\text{-}hs}$ depends on the application), the thermal resistance of the heatsink should be:

$$\frac{150 - 60}{2 \times 6} - 1.3 - 0.2 = 6 \text{ K/W}$$

MAXIMUM FULL-POWER TEMPERATURE

However the **TDA1561Q** has a higher efficiency. The thermal resistance of the heatsink should be:

$$\frac{145 - 60}{2 \times 6} \times \frac{1}{0.6} - 1.3 - 0.2 = 10.3 \text{ K/W}$$

145 °C is the temperature at which BTL will be disabled.

$\frac{1}{0.6}$: coefficient because of 40% higher efficiency.

DC CHARACTERISTICS

V_P = 14.4 V; T_{amb} = 25 °C; measured in Fig.14; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage	note 1	6.0	14.4	18.0	V
$I_{q(tot)}$	total quiescent current	$R_L = \infty$	–	95	150	mA
I_{stb}	standby current		–	1	50	μA
$V_{O(avg)}$	average elco output voltage		–	7.1	–	V
$\lvert\Delta V_O\rvert$	DC output offset voltage	on state	–	–	150	mV
		mute state	–	–	150	mV
Mode select switch (see Fig.6)						
V_3	switch input voltage level	standby condition	0	–	1	V
		mute condition	2	–	3	V
		on condition	4	–	5.5	V
		on condition; BTL disabled	7.5	–	V_P	V
I_{SW}	switch input current	V_{SW} = 7.5 V	–	–	40	μA
Protection						
T_{dis}	BTL disable temperature		–	145	–	°C

Note

1. The circuit is DC adjusted at V_P = 6 to 18 V and AC operating at V_P = 8 to 18 V.

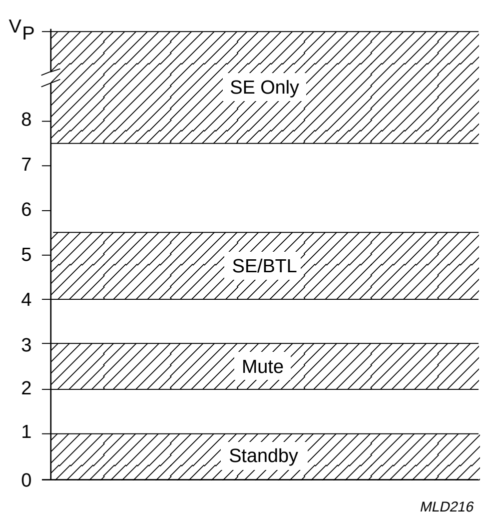


Fig.6 Switching levels of mode select switch.

AC CHARACTERISTICS

V_P = 14.4 V; R_L = 4 Ω; C_{SE} = 1000 µF; f = 1 kHz; T_{amb} = 25 °C; measured in Fig.14; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
P_o	output power	THD = 0.5%	15	18	–	W
		THD = 10%	21	23	–	W
		V_P = 13.2 V; THD = 0.5%	–	14	–	W
		V_P = 13.2 V; THD = 10%	–	20	–	W
THD	total harmonic distortion	P_o = 1 W; f = 1 kHz; note 1	–	0.1	–	%
B	power bandwidth	THD = 1%; P_o = –1 dB with respect to 15 W	–	20 to 15000	–	Hz
f_{lr}	low frequency roll-off	–1 dB; note 2	–	25	–	Hz
f_{hr}	high frequency roll-off	–1 dB	75	–	–	kHz
G_v	closed loop voltage gain		31	32	33	dB
SVRR	supply voltage ripple rejection	R_S = 0 Ω; V_{ripple} = 2 V (p-p)				
		on; f = 1 kHz	45	55	–	dB
		mute; f = 1 kHz	–	55	–	dB
		standby; f = 100 Hz to 10 kHz	80	–	–	dB
CMRR	common mode rejection ratio	R_S = 0 Ω; f_i = 1 kHz	–	80	–	dB
$\|Z_i\|$	input impedance		–	90	–	kΩ
$\|\Delta Z_i\|$	mismatch in input impedance		–	1	–	%
$V_{3(rms)}$	SE to BTL switch voltage level (RMS value)	note 3	–	3	–	V
V_{no}	noise output voltage	on; R_S = 0 Ω; note 4	–	180	350	µV
		on; R_S = 10 kΩ; note 4	–	200	–	µV
		mute; note 5	–	180	–	µV
α_{cs}	channel separation	R_S = 0 Ω	40	60	–	dB
$\|\Delta G_v\|$	channel unbalance		–	0.2	1	dB

Notes

1. The distortion is measured with a bandwidth of 10 Hz to 30 kHz.
2. Frequency response externally fixed (input capacitors determine low frequency roll-off).
3. The SE to BTL switch voltage level is dependent on V_P.
4. Noise voltage measured in a bandwidth of 20 Hz to 20 kHz.
5. Noise output voltage independent of R_S (V_I = 0 V).

INTERNAL PIN CONFIGURATIONS

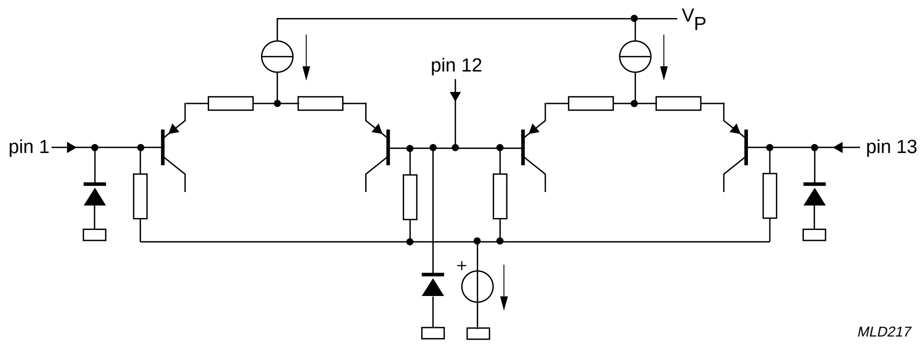


Fig.7 Inputs IN1, CIN and IN2.

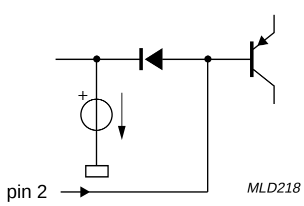


Fig.8 HV_P control pin.

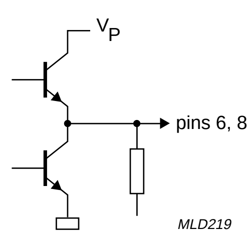


Fig.9 Outputs OUT1 and $\overline{OUT2}$.

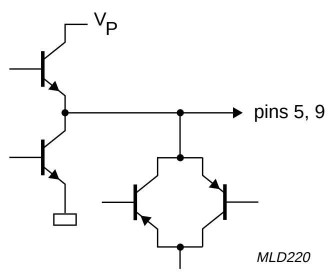


Fig.10 Outputs $\overline{\text{OUT1}}$ and OUT2.

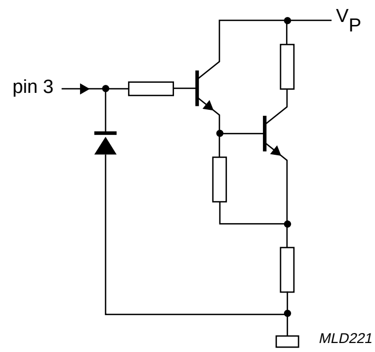


Fig.11 Input MODE.

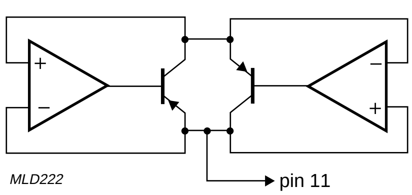


Fig.12 Output C_{11}.

TEST AND APPLICATION INFORMATION

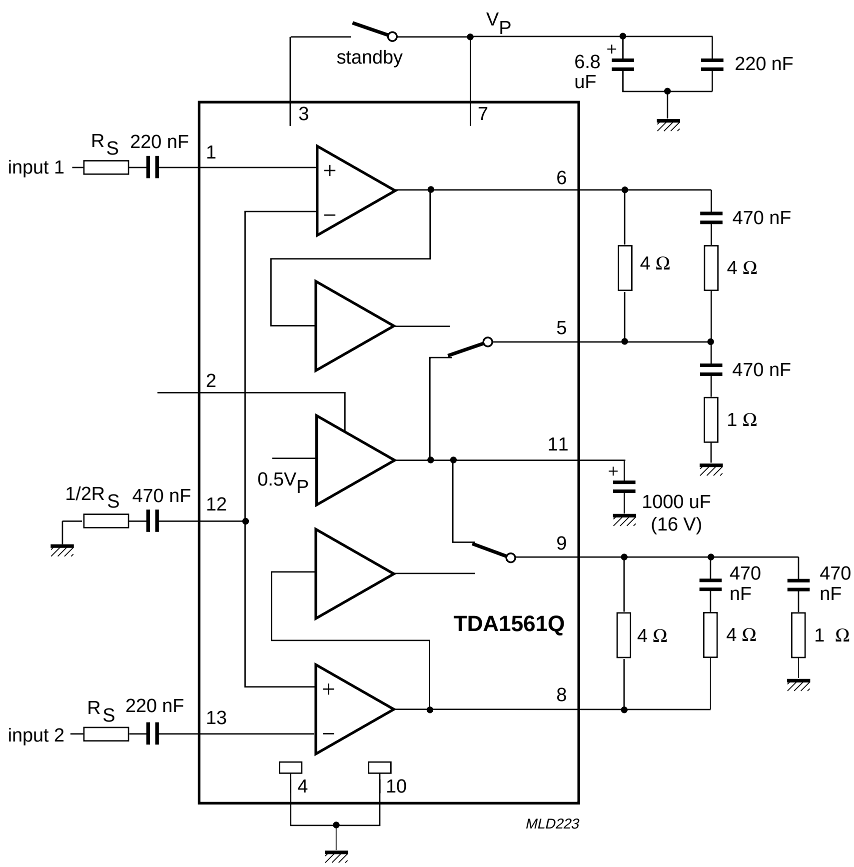


Fig.13 Test diagram.

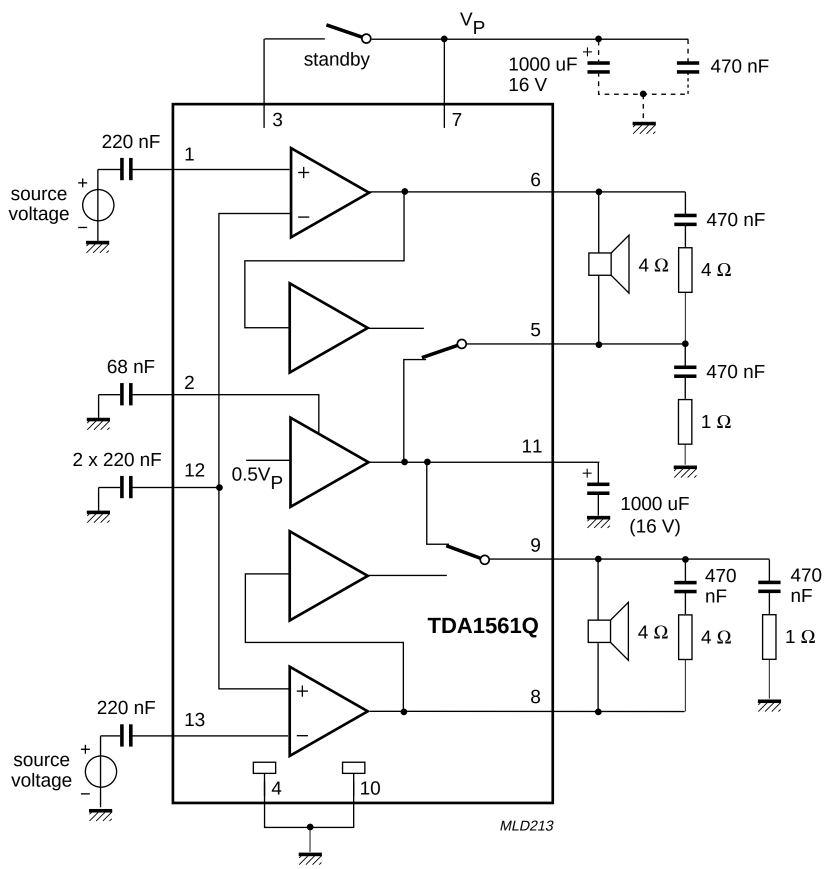


Fig.14 Application diagram.

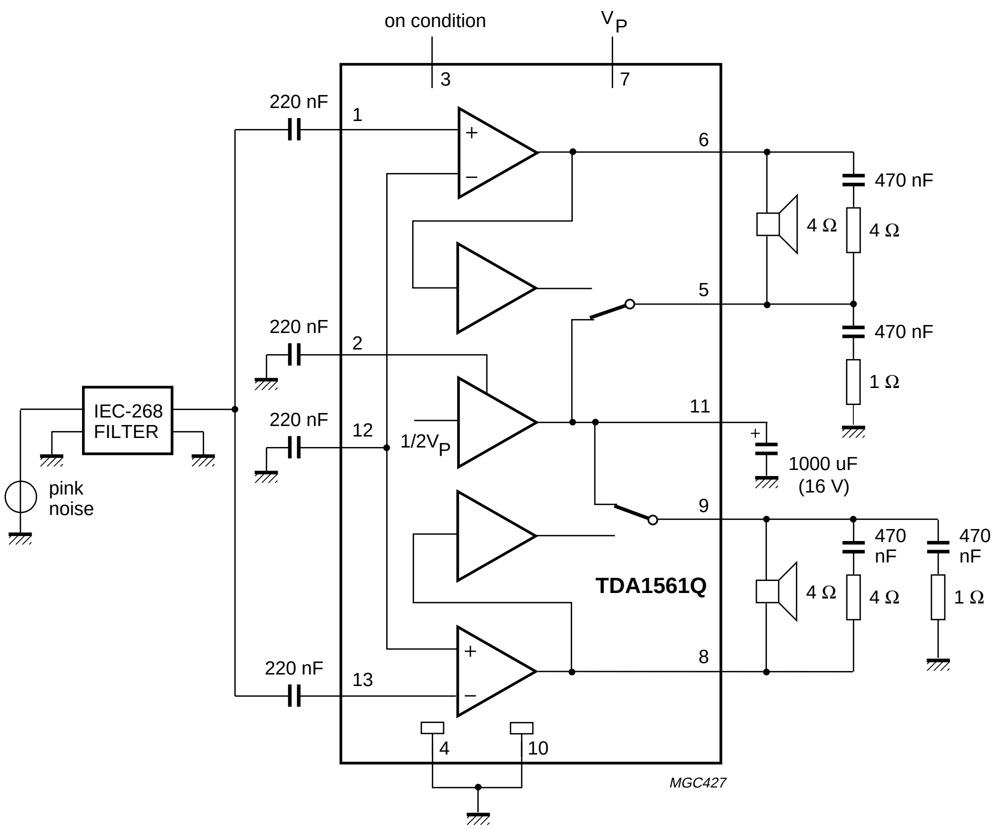


Fig.15 Test and application diagram for dissipation with look alike music signal.

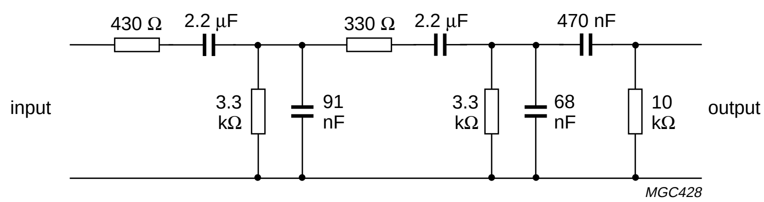
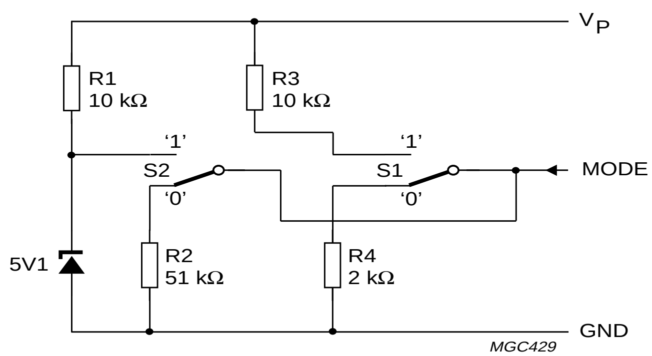


Fig.16 IEC-268 filter.

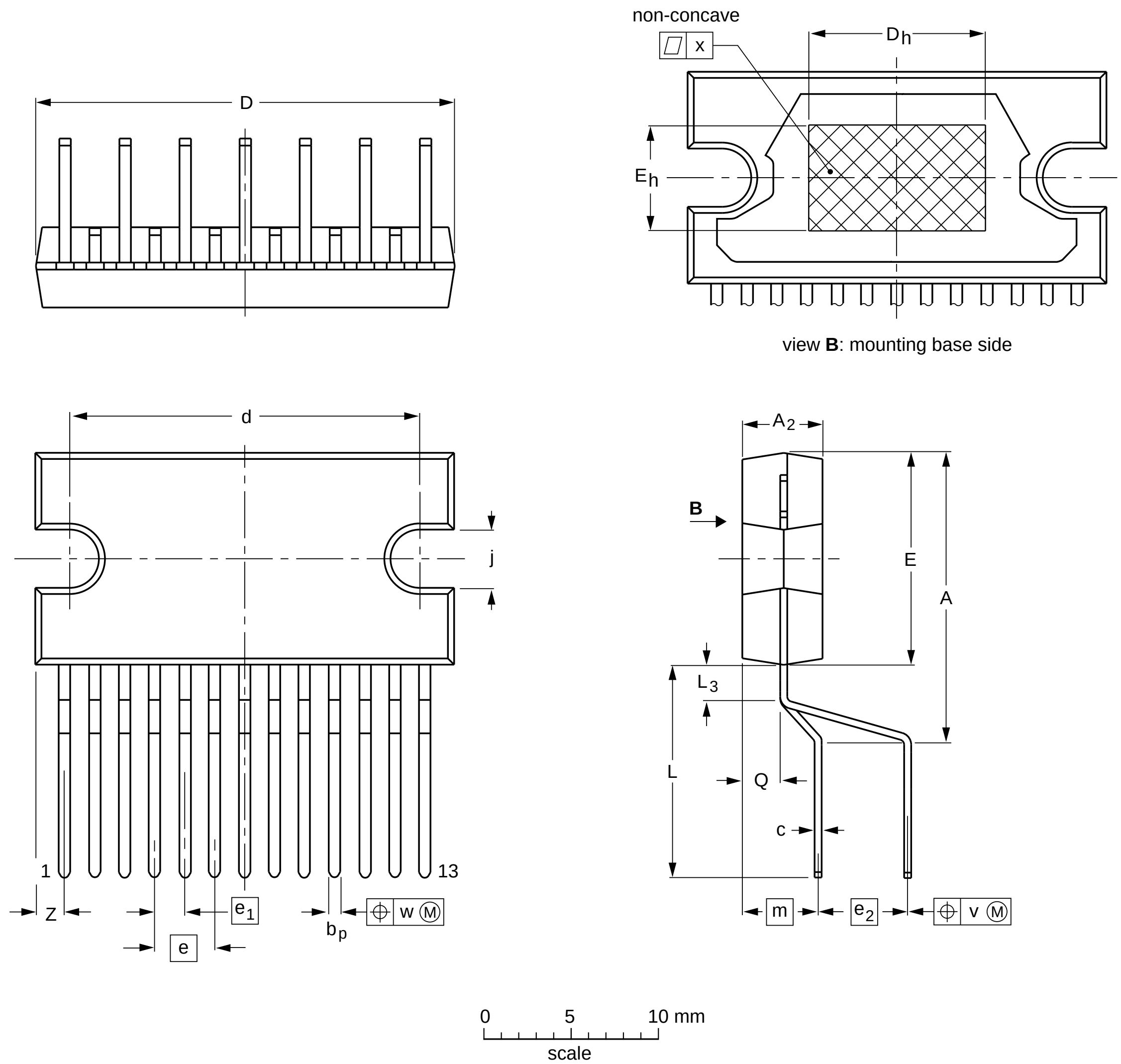


0 0 selects OFF.
0 1 selects MUTE.
1 0 selects SE only.
1 1 selects BTL (normal operation).

Fig.17 Mode select circuit.

PACKAGE OUTLINE

DBS13P: plastic DIL-bent-SIL power package; 13 leads (lead length 12 mm) **SOT141-6**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_2	b_p	c	D[(1)]	d	D_h	E[(1)]	e	e_1	e_2	E_h	j	L	L_3	m	Q	v	w	x	Z[(1)]
mm	17.0 15.5	4.6 4.2	0.75 0.60	0.48 0.38	24.0 23.6	20.0 19.6	10	12.2 11.8	3.4	1.7	5.08	6	3.4 3.1	12.4 11.0	2.4 1.6	4.3	2.1 1.8	0.8	0.25	0.03	2.00 1.45

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT141-6						~~92-11-17~~ 95-03-11

SOLDERING

Plastic DIL-bent-SIL packages

BY DIP OR WAVE

The maximum permissible temperature of the solder is 260 °C; this temperature must not be in contact with the joint for more than 5 s. The total contact time of successive solder waves must not exceed 5 s.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified storage maximum. If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS

Apply the soldering iron below the seating plane (or not more than 2 mm above it). If its temperature is below 300 °C, it must not be in contact for more than 10 s; if between 300 and 400 °C, for not more than 5 s.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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